OIL SEAL ARRANGEMENT

BACKGROUND OF THE INVENTION

[0001] This invention relates to an oil seal arrangement for use with an oil pump used in a vehicle brake actuator or a shock absorber.

[0002] As oil pump assemblies used in vehicle brake actuators, a gear pump is disclosed in JP patent publication 2000-9058 or 2001-80498. The gear pump will be described with reference to Figs. 1 and 2. (Note that Figs. 1 and 2 show an oil seal arrangement embodying the invention.)

[0003] This gear pump assembly includes a housing H formed with suction ports 1 through which oil a is drawn into the housing H and discharge ports 2 through which pressurized oil a is discharged. In the housing H, a rotary shaft 3 driven by a motor M extends in the axial direction of the housing H. The rotary shaft 3 carries a plurality of pump units 10 arranged in the axial direction of the shaft 3. Each pump unit 10 comprises an inner rotor 4 fixed to the rotary shaft 3, and an outer rotor 5 disposed in a casing 7d or 7e so as to be rotatable and eccentric to and in mesh with the inner rotor 4.

[0004] In order to prevent brake oil a pressurized in

the pump units 10 from leaking to outside through gaps between the rotary shaft 3 and pump cylinders 7a and 7c, high-pressure oil seals 8 are disposed therebetween. Further, in order to prevent leak of such pressurized brake fluid even if the high-pressure seals 8 fail, a low-pressure seal 9 is provided between an axially outer portion of the pump cylinder 7c and the rotary shaft 3.

[0005] As the inner and outer rotors of each pump unit 10 rotate, positive pressure and negative pressure are alternately produced in each chamber defined in the pump units. Negative pressure tends to draw outer air into the pump units 10 through the high-pressure seals 8. Air drawn into the pump units will have undue influence on the function of the brake actuator.

[0006] An object of this invention is to provide an oil seal arrangement for such a gear pump which includes, besides the high-pressure seals and low-pressure seal, additional sealing means that can positively prevent infiltration of air into the pumps under negative pressure produced in the pumps.

SUMMARY OF THE INVENTION

[0007] According to the invention, there is provided an oil seal arrangement for a casing in which oil is filled and positive and negative oil pressures are alternately

produced, the oil seal arrangement comprising a high-pressure seal and a low-pressure seal provided in this turn for preventing oil in the casing from leaking to outside, characterized in that an oil seal chamber is provided between the high-pressure seal and the low-pressure seal, the oil seal chamber containing oil of the same quality as the oil in the casing.

[0008] The oil in the oil seal chamber, which is a liquid, has a high sealability. Since the oil in the oil seal chamber is of the same quality as the oil in the casing, even if the former mixes into the latter, this will pose no problems whatsoever. As used herein, "oil of the same quality" encompasses any oil that will have no significant undue influence on the oil in the casing even if they are mixed together.

[0009] The oil seal chamber is not filled with oil but preferably has an air layer. If oil in the casing should leak through the high-pressure seal into the oil seal chamber, the air in the oil seal chamber will be compressed, thereby absorbing any increase in the volume of the oil seal chamber. This prevents excessive and sharp pressure increase in the oil seal chamber, thus preventing failure of the low-pressure seal.

[0010] According to the present invention, there is also provided an oil seal arrangement wherein the casing is a pump cylinder, a motor mounted in the pump cylinder, the

rotary shaft extending from the motor into the pump cylinder, a pump unit driven by the motor to suck and discharge oil from and into the pump cylinder, the oil seal chamber being provided between the pump and the motor around the rotary shaft, the high-pressure seal being disposed between the pump and the oil seal chamber, the oil seal chamber disposed between the high-pressure seal and the low-pressure seal around the rotary shaft, and the low-pressure seal being disposed between the oil seal chamber and the motor around the rotary shaft, the oil seal chamber being filled with such an amount of oil that the rotary shaft will be completely submerged in the oil in the oil seal chamber, the oil being of the same quality as the oil in the pump cylinder.

[0011] Oil may be injected into the oil seal chamber through a hole formed in the casing such as a pump cylinder. But the oil seal arrangement may further comprises a recess chamber formed in the outer periphery of the casing, a first passage through which the recess chamber communicates with the oil seal chamber, and an oil injection port communicating with the recess chamber. Since oil flows into the recess chamber, too, the entire amount of oil increases. Also, control of the amount becomes easier. The provision of a recess chamber makes easier the injection of oil.

[0012] The first passage is always submerged in the oil

layer in the oil seal chamber. The oil seal arrangement preferably further comprises a second passage through which the recess chamber communicates with the oil seal chamber.

[0013] With this arrangement, oil flows into the oil seal through the second passage and through the recess chamber and the first passage. Thus, oil can smoothly flow into the oil seal chamber, while replacing air. The recess chamber communicates with the oil seal chamber through the first passage. Thus, the oil in the oil chamber is kept at the same level as the oil in the recess, so that one can check the oil level in the oil seal chamber by checking the oil level in the recess chamber. But ordinarily, the oil level in the oil seal chamber is determined based on the amount of oil injected.

[0014] Preferably, the oil seal chamber and the recess chamber have both an oil layer and an air layer, the first passage is formed at a portion submerged in the oil layers of the oil seal chamber and the recess chamber, and the second passage is formed at a portion communicating with the air layers of the oil seal chamber and the recess chamber. With this arrangement, the first passage serves as an air vent when oil is injected into the oil seal chamber.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] Other features and objects of the present invention will become apparent from the following description made with reference to the accompanying drawings, in which:

Fig. 1 is a partially cutaway front view of a first embodiment;

Figs. 2 and 3 are sectional views of the embodiment of Fig. 1;

Figs. 4A and 4B are sectional views of other embodiments;

Fig. 5 is a partially cutaway front view of still another embodiment; and

Fig. 6 is a partially cutaway front view of a further embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0016] Figs. 1 to 3 show one embodiment of the present invention applied to an oil gear pump P which has two pump units 10 mounted in the housing H of a vehicle brake actuator. The pump driving motor M is bolted to a flange of the cylinder 7c.

[0017] Each pump unit 10 has an inner rotor 4 fixed to the rotary shaft 3 by keys 11 and an outer rotor 5 mounted in the casing 7d or 7e so as to be rotatable and

eccentric to and in mesh with the inner rotor 4. Gaps are defined between the inner and outer rotors 4, 5 as shown in Fig. 2. When the rotary shaft 3 is rotated by the motor M, the inner and outer rotors 4, 5 of each pump unit rotate together. As the rotors rotate, the volume of each of such gaps alternately increases and decreases. Each inlet port 1 communicates with one side of such gaps through a fluid line 1a, while each outlet port 2 communicates with the other side of the gaps through a fluid line 2a. Thus, oil a is sucked into the gaps from the suction port 1 under negative pressure in the gaps and discharged from the gaps into the discharge port 2 under positive pressure in the gaps.

[0018] Each pump unit 10 is disposed between the center cylinder 7a and one of the side cylinders 7b and 7c. The pump casing 7d is welded to the center cylinder 7a and the side cylinder 7c along its entire outer edge. The pump casing 7e is welded to the center cylinder 7a and the side cylinder 7b along its entire outer edge. Each fluid line 1a and 2a, the suction port 1 and the discharge port 2 are formed in one of the side cylinders 7b and 7c. Each of the side cylinders 7b and 7c is further formed with an annular groove 13 in its surface opposing the pump unit 10. A seal member 12 fills the groove 13 to separate the fluid lines 1a and 2a from each other.

[0019] The rotary shaft 3 is rotatably supported by the

cylinders 7a, 7b and 7c (the entire cylinders are denoted by numeral 7) through bearings. The pump assembly P is fastened in position in the housing H by leaf springs 15 disposed between the end wall of the housing H and one end of the cylinder 7b, and a nut 16 threaded into the housing H while abutting the side cylinder 7c.

[0020] One of the high-pressure seals 8 is provided between the center cylinder 7a and the rotary shaft 3 to separate the gear pump units 10 from each other. The other high-pressure seal 8, which is disposed between the side cylinder 7c and the rotary shaft 3, separates one of the pump units 10 from the motor M. Axially outside of the other high-pressure seal 8, in the side cylinder 7c around the rotary shaft 3, an oil seal chamber 20 is defined. The low-pressure seal 9 forms the axially outer wall of the oil seal chamber 20. A member 8a prevents slipping of the high-pressure seal 8.

[0021] An annular recess chamber 21 is formed in the inner surface of the housing H and in the outer surface of the side cylinder 7c. At its lowest portion (in Fig. 1), the recess chamber 21 communicates with an oil injection port 22 formed in the housings H. At its highest and lowest points, the recess chamber 21 also communicates with the oil seal chamber 20 through passages 23a and 23b, respectively (Fig. 3). When oil <u>a</u> of the same type as brake oil that is sucked into and discharged from the

pump unit 10 is injected through the oil injection port 22, the oil will flow into the oil seal chamber 20 through the passages 23a and 23b until the rotary shaft 3 in the chamber 20 is completely submerged in the oil as shown in Fig. 3. In this state, the oil in the oil seal chamber 20 serves as an additional seal between the rotary shaft 3 and the cylinder 7c. That is, it completely prevents leak of air into the pump units 10.

[0022] An air layer 24 is present in the chamber 20 over the oil layer. If oil should leak from the pump units 10 into the oil seal chamber 20, the air layer 24 will be compressed, thus preventing any excessive and sharp pressure rise in the chamber 20.

[0023] The oil injection port 22 is closed by e.g. pressing a steel ball 22a into the port 22. O-rings 18 are provided between the housing and the cylinders 7.

[0024] As shown in Fig. 4A, instead of the annular recess chamber 21, a semicircular recess may be formed. The upper passage 23a shown in Fig. 4A and Fig. 3 may be omitted. In this case, oil is replaced with air in the oil seal chamber 20 through the lower passage 23b. Also, as shown in Fig. 4B, oil can be injected from top.

[0025] In the arrangement of Fig. 5, an oil injection port 22 communicating with the oil seal chamber 20 is formed in the cylinder 7c. In this arrangement, oil is introduced into the chamber 20 before the pump assembly P

is mounted in the housing. When a required amount of oil is injected into the chamber 20, the oil pump assembly is inserted into the housing H so that the oil injection port 22 is closed by the housing. Of course, neither the recess chamber 21 nor the steel ball 22a is needed in this arrangement.

[0026] The invention is applicable not only to gear pump assemblies as shown, but also to any other hydraulic units which alternately produce negative and positive oil pressures in a casing and having a double oil seal mechanism comprising a high-pressure seal and a low-pressure seal. Such pressure generating units include a plunger pump used in a vehicle brake actuator and a shock absorber.

[0027] A shock absorber P' having the characterizing feature of the invention is shown in Fig. 6. The shock absorber P' of Fig. 6 includes an oil seal chamber 20 similar to those shown in Figs. 1-5 between a high-pressure seal 8 and a low-pressure seal 9. Of course, the recess chambers and/or passages shown in Figs. 1-5 may be formed. The shock absorber itself comprises a piston 32 and a piston rod 33 slidably received in the cylinder 31. Controlled hydraulic pressure is supplied to the shock absorber from a pressure source comprising a pump 35, a pressure sensor 36, a pressure accumulator 37 and solenoid valves 38 and 39.

[0028] If the oil seal chamber 20 is completely filled with oil with no air contained therein, oil in the pressure chamber of the shock absorber can leak into the oil seal chamber 20 through the high-pressure seal 8. Because oil is incompressible, there is a possibility of compressing the low-pressure seal 9 until it fails. In order to avoid this problem, it is necessary to connect the oil seal chamber 20 to a reservoir 34, as shown in Fig. 6 by dotted line, to absorb extra oil. But according to this invention, the oil seal chamber 20 is not completely filled with oil with an air layer 24 present in the chamber 20. Thus, even if oil leaks through the high-pressure seal 8 into the chamber 20, the air layer 24 is compressed, thereby absorbing any increase in the volume of the oil in the chamber 20. Thus, it is not necessary to release oil into the reservoir 34. This means that the reservoir 34 and the pipe connecting the chamber 20 with the reservoir 34 can be omitted. It is thus possible to reduce the size of the entire system.

[0029] The oil seal arrangement according to the invention improves sealability of a hydraulic unit that alternately produces positive pressure and negative pressure without unduly increasing its size.